Claims

1. A hybrid optical network comprising:

a single channel optical ring network (1),

a plurality of ring nodes (2) of the single channel optical ring network (1), each of the ring nodes (2) being adapted to communicate single channel optical data packets over the single channel ring network (1),

a star subnetwork (3) comprising:

- a central wavelength router (5) having a plurality of input ports and a plurality of output ports,
- a plurality of combiners (6) each having a plurality of input ports and one output port, the output ports of the combiners (6) being connected to the input ports of the central wavelength router (5),
- a subset of the ring nodes (4) of the ring network, each node (4) of the subset including a tunable transmitter (26) and a tunable receiver (25) to communicate optical data packets over the star subnetwork (3), the tunable transmitters (26) each being connected to an input port of one of the combiners (6), wherein

optical data packets routed between two ring nodes (4) of the subset over the star subnetwork (3) are assigned a specific wavelength that determines the routing of the data packets through the central wavelength router (5).

2. The network according to claim 1, wherein the central wavelength router (5) is a single arrayed waveguide grating.

3. The network according to claim 1 or 2, additionally comprising a plurality of wavelength independent splitters (7) each having one input port and a plurality of output ports, the input ports of the splitters (7) being connected to the output ports of the central wavelength router (5), the output ports of the splitters (7) each being connected to a tunable receiver (25) of one of the nodes (4) of the subset.

4. The network according to any preceding claim, wherein the nodes (4) of the subset are equally distributed among the ring nodes (2).

5. The network according to any preceding claim, wherein an optical amplifier (8) is arranged between the output port of a combiner (6) and the corresponding input port of the central wavelength router (5).

6. The network according to any of claims 3 to 5, wherein an optical amplifier (8) is arranged between an output port of the central wavelength router (5) and the input port of the corresponding splitter (7).

7. The network according to any preceding claim, wherein each node (4) of the subset comprises conversion means (21, 22) for optical to electrical to optical conversion of the signals, and wherein the tunable transmitter (26) and the tunable receiver (25) of a node (4) perform electrical to optical and optical to electrical signal conversion, respectively.

8. The network according to claim 7, wherein each node (4) of the subset comprises transit queues (23) and station queues (24), the station queues (24) comprising receive queues (241) and transmit queues (242), one receive queue (241) being connected to the tunable receiver (25) and

one transmit queue (242) being connected to the tunable transmitter (26).

9. The network according to any preceding claim, further comprising protocol means for routing optical data packets to be sent from a given source ring node (2, A) to a given destination ring node (2, B) over the shortest network path, including routing the data packets over the single channel ring network (1) and over the star subnetwork (3).

10. The network according to any preceding claim, additionally comprising:

- means for assigning a wavelength to data packets being sent over the star subnetwork (3) from a given source subset node (4) of the subset to a given destination subset node (4) of the subset, the wavelength determining the route of the data packets through the star subnetwork (3),
- means for tuning the tunable transmitter (26) of the source subset node (4) to the assigned wavelength, and
- means for tuning the tunable receiver (25) of the destination subset node (4) to the assigned wavelength.

11. The network according to claim 10, wherein the means for assigning a wavelength comprise:

- means for determining the shortest route for data packets being sent from a given source ring node (2, A) to a given destination ring node (2, B),
- means for determining within the shortest route a source subset node (4) and a destination subset node (4) routing the data packets over the star subnetwork (3) in a short-cut,

means for determining a wavelength to route the data packets from the source subset node (4) to the destination subset node (4).

12. The network according to claim 10 or 11, further comprising means for putting the data packets received at the destination subset node (4) on the single channel optical ring network (1) in case the destination subset node (4) is different from the destination node (2, B).

13. The network according to any preceding claim, wherein the single channel optical ring network (1) is a bidirectional dual-fiber ring network or a bidirectional single-fiber ring network.

14. The network according to any preceding claim, wherein the hybrid optical network is a packet switched metropolitan area network.

15. The network according to any preceding claim, wherein a passive star coupler (15) is arranged in parallel with the central wavelength router (5), each node (4) of the subset being coupled both to the central wavelength router (5) and the passive star coupler (15), and with the central wavelength router (5) routing data packets assigned to wavelengths of a first waveband and the passive star coupler (15) routing data packets assigned to wavelengths of a second waveband.

16. A method of routing data packets between a source ring node (2, A) and a destination ring node (2, B) of a hybrid optical network that comprises a peripheral optical ring network (1) with a plurality of ring nodes (2) and a star network (3) with a central wavelength router (5) and a subset of the ring nodes (2), each node (4) of the subset including means (25, 26) to communicate

optical data packets over the star subnetwork (3), the method comprising:

- putting data packets to be transmitted on the optical ring network (1) at the source ring node (2, A),
- determining a source subset node (4) and a destination subset node (4) of the subset which are part of a route for data packets being sent from the source ring node (2, A) to the destination ring node (2, B),
- pulling incoming source ring node data packets from the optical ring network (1) at the source subset node (4),
- transmitting the pulled data packets over the star subnetwork (3) to the destination subset node (4),
- sending the data packets from the destination subset node (4) to the destination ring node (2, B) over the optical ring network (1) if the destination ring node (2, B) is unequal to the destination subset node (4), and
- taking the data packets from the optical ring network (1) at the destination ring node (2, B).

17. The method of claim 16, wherein the source subset node (4) and the destination subset node (4) are nodes of the shortest route for data packets from the source ring node (2, A) to the destination ring node (2, B) over the hybrid network.

18. The method of claim 16 or 17, wherein the optical ring network (1) is a single channel optical ring network, the optical data packets pulled from the single channel optical ring network (1) being converted in the source subset node (4) to an optical wavelength that allows routing of the data packets to the destination subset node (4) over the star subnetwork (3).

19. The method of claim 18, wherein the optical data signals on the optical ring network (1) are converted to electrical data signals when taken from the ring, and wherein the electrical data signals are converted to optical data signals of a specific wavelength that determines the routing of the data signals across the star subnetwork (3).

20. The method of claim 19, wherein the optical data signals are placed in a transmit queue (242) when taken from the optical ring network (1) and transmitted from the transmit queue (242) to a tunable transmitter (26) of the source subset node (4).

21. The method of claim 19 or 20, additionally comprising the step of regenerating the signal after conversion to an electrical signal.

22. The method of any of claims 16 to 21, additionally comprising the step of the source subset node (4) transmitting control data with node reservation information to the other nodes (4) of the subset prior to transmitting the data packets over the star subnetwork (4).

23. The method of claim 22, wherein the node reservation information comprises data about the source address of the source subset node (4), data about the destination address of the destination subset node (4) and data about the length of the corresponding data packet.

24. A hybrid optical network comprising:
    - a single channel optical ring network,
    - a plurality of ring nodes of the single channel optical ring network, each of the ring nodes being adapted to communicate single channel optical data packets over the single channel ring network,
    - a star subnetwork comprising:
        - a central wavelength router having a plurality of input ports and a plurality of output ports,
        - a plurality of combiners each having a plurality of input ports and one output port, the output ports of the combiners being connected to the input ports of the central wavelength router,
        - a subset of the ring nodes of the ring network, each node of the subset including a tunable transmitter and a tunable receiver to communicate optical data packets over the star subnetwork, the tunable transmitters each being connected to an input port of one of the combiners, wherein
    - optical data packets routed between two ring nodes of the subset over the star subnetwork are assigned a specific wavelength that determines the routing of the data packets through the central wavelength router.

25. The network according to claim 24, wherein the central wavelength router is a single arrayed waveguide grating.

26. The network according to claim 24 or 25, additionally comprising a plurality of wavelength independent splitters each having one input port and a plurality of output ports, the input ports of the splitters being connected to the output ports of the central wavelength router, the output ports of the splitters each being

connected to a tunable receiver of one of the nodes of the subset.

27. The network according to claim 24, wherein the nodes of the subset are equally distributed among the ring nodes.

28. The network according to claim 24, wherein an optical amplifier is arranged between the output port of a combiner and the corresponding input port of the central wavelength router.

29. The network according to claim 26, wherein an optical amplifier is arranged between an output port of the central wavelength router and the input port of the corresponding splitter.

30. The network according to claim 24, wherein each node of the subset comprises conversion means for optical to electrical to optical conversion of the signals, and wherein the tunable transmitter and the tunable receiver of a node perform electrical to optical and optical to electrical signal conversion, respectively.

31. The network according to claim 30, wherein each node of the subset comprises transit queues and station queues, the station queues comprising receive queues and transmit queues, one receive queue being connected to the tunable receiver and one transmit queue being connected to the tunable transmitter .

32. The network according to claim 24, further comprising protocol means for routing optical data packets to be sent from a given source ring node to a given destination ring node over the shortest network path, including routing the data packets over the single channel ring network and over the star subnetwork.

33. The network according to claim 24, additionally comprising:
- means for assigning a wavelength to data packets being sent over the star subnetwork from a given source subset node of the subset to a given destination subset node of the subset, the wavelength determining the route of the data packets through the star subnetwork,
- means for tuning the tunable transmitter of the source subset node to the assigned wavelength, and
- means for tuning the tunable receiver of the destination subset node to the assigned wavelength.

34. The network according to claim 33, wherein the means for assigning a wavelength comprise:
- means for determining the shortest route for data packets being sent from a given source ring node to a given destination ring node),
- means for determining within the shortest route a source subset node and a destination subset node routing the data packets over the star subnetwork in a short-cut,
- means for determining a wavelength to route the data packets from the source subset node to the destination subset node.

35. The network according to claim 33, further comprising means for putting the data packets received at the destination subset node on the single channel optical ring network in case the destination subset node is different from the destination node.

36. The network according to claim 24, wherein the single channel optical ring network is a bidirectional dual-fiber ring network or a bidirectional single-fiber ring network.

37. The network according to claim 24, wherein the hybrid optical network is a packet switched metropolitan area network.

38. The network according to claim 24, wherein a passive star coupler is arranged in parallel with the central wavelength router, each node of the subset being coupled both to the central wavelength router and the passive star coupler, and with the central wavelength router routing data packets assigned to wavelengths of a first waveband and the passive star coupler routing data packets assigned to wavelengths of a second waveband.

39. A method of routing data packets between a source ring node and a destination ring node of a hybrid optical network that comprises a peripheral optical ring network with a plurality of ring nodes and a star network with a central wavelength router and a subset of the ring nodes, each node of the subset including means to communicate optical data packets over the star subnetwork, the method comprising:

- putting data packets to be transmitted on the optical ring network at the source ring node,
- determining a source subset node and a destination subset node of the subset which are part of a route for data packets being sent from the source ring node to the destination ring node,
- pulling incoming source ring node data packets from the optical ring network at the source subset node,
- transmitting the pulled data packets over the star subnetwork to the destination subset node),
- sending the data packets from the destination subset node to the destination ring node over the optical ring network if the destination ring node is unequal to the destination subset node, and
- taking the data packets from the optical ring network at the destination ring node.

40. The method of claim 39, wherein the source subset node and the destination subset node are nodes of the shortest route for data packets from the source ring node to the destination ring node over the hybrid network.

41. The method of claim 39 or 40, wherein the optical ring network is a single channel optical ring network, the optical data packets pulled from the single channel optical ring network being converted in the source subset node to an optical wavelength that allows routing of the data packets to the destination subset node over the star subnetwork.

42. The method of claim 41, wherein the optical data signals on the optical ring network are converted to electrical data signals when taken from the ring, and wherein the electrical data signals are converted to optical data signals of a specific wavelength that determines the routing of the data signals across the star subnetwork.

43. The method of claim 42, wherein the optical data signals are placed in a transmit queue when taken from the optical ring network and transmitted from the transmit queue to a tunable transmitter of the source subset node.

44. The method of claim 42, additionally comprising the step of regenerating the signal after conversion to an electrical signal.

45. The method of claim 39, additionally comprising the step of the source subset node transmitting control data with node reservation information to the other nodes of the subset prior to transmitting the data packets over the star subnetwork.

46. The method of claim 45, wherein the node reservation information comprises data about the source address of the source subset node, data about the destination address of the destination subset node and data about the length of the corresponding data packet.